depths of three hundred to nine hundred feet, and having small but constant flow of mineralized water. In these wells the conditions of hydrostatic pressure appear to be absent, and in only one is there any show of gas; and for these and other wells the writer assigned a cause not usually found, for artesian flow. He called it *rock-pressure*, and said: "All rocks in the earth's crust contain some water. The more porous rocks contain the greater quantity. At a distance below the surface, the superincumbent mass subjects the rock masses to enormous pressure. If we assume that the rocks of Kansas to a depth of one thousand feet have an average specific gravity three times as great as that of water, we are probably within bounds, as, though limestones and sandstones are usually somewhat less, the presence of iron in many of the beds will bring up the average considerably. On this basis, a prism of the rocks to the depth of 600 feet and one inch square would weigh 781 pounds, which is equivalent to a pressure of 52 atmospheres. If then 25 feet be taken as the measure of a column of these mineralized waters equivalent to one atmosphere, the rock-pressure would be more than the equivalent of a column of water twice this height.

"Let a water-bearing stratum at a depth of 600 feet be pierced by the drill; we should then have the rock-pressure of 52 atmospheres squeezing the water out of the rock-pores, and, granting sufficient plasticity in the rock, and a sufficient quantity of water, it must rise in the tube, which has only the pressure of one atmosphere upon it. A large bore to the well and a small supply of water would be against its reaching the surface. On the other hand, a bed-rock with mobile molecules at or near saturation, under this enormous pressure, must cause in a narrow tube a flowing well. At 300 feet the rock-pressure would be only half that given above, or 26 atmospheres, and the column of water to be supported would be diminished in proportion. At other depths the same proportions will hold good.

"Here, then, we have a force that may be an aid to an artesian flow, which is mainly due to the usual causes of such flow, and which is a most efficient cause for the constant flow of wells whose depth is great, and whose quantity of water is small. We are inclined to consider rock-pressure as the cause of the flow of the Pottawatomie and Morton county wells—at least till future search shall make it more probable that it is due to the usual causes of artesian wells."

SOME KANSAS MINERAL WATERS.

BY PROF. E. H. S. BAILEY, STATE UNIVERSITY.

Although this is a comparatively new State, its resources have been wonderfully developed within the past ten years. In common with other possible sources of wealth, the mineral waters have received much attention. Some of them flow from springs, while others are obtained from wells both shallow and artesian. In order that a permanent record may be made of the analysis of some of these waters, the author has selected some of the more important ones, that have been examined in the laboratory of the State University, and presents the analyses for publication.

MARION MINERAL WELLS.

These wells, or more properly this well, is situated in the northern part of Marion, about fifty feet from a small creek. The well, which was drilled as a prospect well, is 175 feet deep, and has two pumps; the first takes the water from a depth of 50 feet, at a point just above the rock, and the other takes the water from a point 25 feet above the bottom. Both contain some hydrogen sulphide gas when first drawn. The temperature is 57° F. The waters are utilized, the upper for drinking and the

lower for bathing purposes. The analysis shows the upper vein to be a saline water, and the lower a strong brine, much stronger than sea-water.

Upper Vein.

Upon analysis the water is shown to contain the following substances, the result being expressed in grams per liter:

Calcium oxide	.5341
Magnesium oxide	.3733
Sodium oxide	.6064
Ferric oxide	.0056
Sulphuric anhydride	1.3736
Carbonic anhydride (calculated)	.2924
Chlorine	.5780
Silica	.0216
Organic matter	Trace

These constituents are probably combined as follows, expressing the results in grains per U. S. gallon of 231 cubic inches:

Sodium chloride	55.548
Magnesium sulphate	65.310
Sodium sulphate	13.594
Calcium sulphate	48.736
Calcium bicarbonate	32.052
Iron bicarbonate	0.723
Silica	1.261
Sodium hydrosulphate	Trace
Organic matter	Trace
Total solids	217.224

Lower Vein.

Upon analysis the water is shown to contain the following constituents, the result being estimated in grams per liter:

Calcium oxide	1.3858
Magnesium oxide	.7772
Sodium oxide	80.2090
Ferric oxide	.0044
Sulphuric anhydride	6.9944
Chlorine	33.1232
Silica	.0128
Carbonic anhydride	Trace
Organic matter	Trace

These constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Sodium chloride	3183.230
Sodium sulphate	358.230
Calcium sulphate	196.228
Magnesium sulphate	135.974
Iron bicarbonate	.010
Silica	.013
Organic matter	Trace
Total solids	3873.685

CHINGAWASSA SPRINGS.

These springs are situated about three miles north of Marion, Marion county. Within a radius of a quarter of a mile there are at least 50 springs. Most of these, however, are ordinary fresh-water springs. There are three or four that are strongly impregnated with mineral matter. The analysis of one of these is given, as it is a representative of the class. This is the so-called "North spring." A 1½-inch stream is constantly running from it. The temperature is 57.2° F. On the bottom and sides

of the spring may be seen a white deposit of sulphur, and the odor of hydrogen sulphide is quite perceptible.

Upon analysis the water is shown to contain the following constituents, the results being estimated in grams per liter:

Calcium oxide	.8422
Magnesium oxide	.1308
Sodium oxide	.0505
Potassium oxide	.0048
Ferric oxide	.0010
Silica	.0162
Sulphuric anhydride	1.2704
Carbonic anhydride (calculated)	.1432
Chlorine	.0280
Hydrogen sulphide	

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Potassium sulphate	0.490
Sodium chloride	2.688
Sodium sulphate	3.138
Magnesium sulphate	22.884
Calcium sulphate	97.391
Calcium bicarbonate	24.867
Iron bicarbonate	0.175
Silica	0.945
Sodium bicarbonate	Trace
Sodium hydrosulphate	Trace
Total solids	152.578

Free carbonic acid gas.
Free hydrogen sulphide gas.

PARSONS MINERAL WELL.

This water comes from a well about 30 feet in depth, situated upon a farm on the open prairie. It is remarkable in the large amount of nitrates contained, and the abundance of magnesium salts.

Upon analysis, the water is shown to contain the following ingredients, estimated in grams per liter:

Calcium oxide	.6914
Magnesium oxide	1.3528
Sodium oxide	.4454
Potassium oxide	.0074
Ferric oxide	.0008
Silica	.0146
Sulphuric anhydride	3.6742
Chlorine	.1414
Nitric anhydride	.0162
Organic matter	Trace
Carbonic anhydride (calculated)	.5173

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Potassium sulphate	.804
Sodium nitrate	1.487
Sodium chloride	13.590
Sodium sulphate	43.260
Magnesium sulphate	236.680
Calcium sulphate	52.950
Calcium bicarbonate	55.380
Sodium bicarbonate	Trace
Iron bicarbonate	.134
Silica	.851
Organic matter	Trace
Total solids	405.236

CARBONDALE SPRING.

This is situated about two miles north of the city, on the Topeka road. The temperature is 54° F. The water is quite abundant. This water contains a comparatively large quantity of free ammonia, and little albuminoid ammonia. From a knowledge of the situation of the spring, it would not seem possible that the ammonia could come from any surface contamination, and it is probably a natural constituent of the water.

Upon analysis the water is shown to contain the following ingredients, estimated in grams per liter:

Calcium oxide	.1121
Magnesium oxide	.0443
Sodium oxide	.9742
Potassium oxide	.0097
Ferric oxide	.0004
Alumina	.0001
Silica	.0051
Sulphuric anhydride	.3707
Phosphoric anhydride	.0001
Boric anhydride	.0097
Chlorine	.7946
Bromine	.0009
Iodine	.0001
Carbonic anhydride (calculated)	.2630
Ammonia	.0025

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches.

Sodium chloride	76.361
Sodium sulphate	35.817
Calcium bicarbonate	16.959
Magnesium bicarbonate	9.430
Calcium sulphate	1.639
Potassium sulphate	1.044
Sodium bicarbonate	.910
Sodium biborate	.752
Sodium bromide	.070
Sodium iodide	.003
Alumina	.560
Silica	.297
Iron bicarbonate	.069
Sodium phosphate	.006
Ammonia sulphate	Trace
Total solids	143.917

EUREKA MINERAL WELL.

This water comes from a well something over one hundred feet in depth. From the analysis it will be seen that besides the ordinary constituents it contains bromides, iodides, phosphates, and borates.

Upon analysis the water is shown to contain the following ingredients, estimated in grams per liter:

Calcium oxide	.3626
Magnesium oxide	.1835
Sodium oxide	3.6369
Potassium oxide	.0833
Ferric oxide	.0012
Alumina	.0017
Sulphuric anhydride	.4834
Chlorine	4.3919
Phosphoric anhydride	.0003

Silica	.0137
Bromine	.0004
Iodine	.0001
Boric anhydride	Trace
Nitric anhydride	Trace
Organic matter	Trace
Carbonic anhydride (calculated)	.2178

The constituents are probably combined as follows, the results being expressed in grains per U. S. gallon of 231 cubic inches:

Sodium chloride	400.250
Magnesium chloride	18.119
Potassium sulphate	7.417
Calcium sulphate	42.135
Magnesium bicarbonate	11.220
Calcium bicarbonate	10.980
Iron bicarbonate	.204
Sodium bicarbonate	Trace
Sodium nitrate	Trace
Sodium bromide	.026
Sodium iodide	.006
Sodium phosphate	.034
Alumina	.099
Silica	.799
Organic matter	Trace
Total solids	491.289

In conclusion, I wish to acknowledge the able assistance afforded me by Mr. E. C. Franklin, who has performed a large portion of the analytical work on the above waters.

NOTES ON THREE SPECIES OF GOPHERS FOUND AT LAWRENCE, KAS.

BY PROF. L. L. DYCHE,* STATE UNIVERSITY.

I. Ground Squirrel (*Spermophilus tridecemlineatus*). Rather common. It digs up corn, squash, melon and other seeds soon after they are planted. Farmers say that these ground squirrels can smell the seeds in the ground, for they always dig straight down to them. Some watermelon farmers report that the squirrels frequently stop the growth of a vine by nibbling or cutting off the tender runner near the end. Some cases have been reported where they cut holes in the nearly ripe musk- and watermelons and ate the seeds out.

II. Ground Squirrel (*Spermophilus Franklini*). At present not common, except in certain localities in the eastern half of the State. Not much damage done by this species — at least not much thus far reported, except from certain localities, and most of these where fields were inclosed by stone walls or hedges, which gave the squirrels special protection. The squirrels dig up the corn, and sometimes other seeds, soon after it is planted, in the spring. In the fall they do some damage by burrowing under corn-shocks; they eat some of the corn, and usually carry considerable down into their burrows. They were very common on my father's farm, (at Auburn, Shawnee county, Kas.,) about fifteen years ago.† They would dig up the corn almost as fast as it was planted for a distance of from fifteen to fifty yards all along the stone walls wherever the latter inclosed the fields. On an average, there could not have been less than one squirrel for each rod of fence; apparently there

* Read by title at the Leavenworth meeting, Nov. 1, 1888.

† Information from various sources goes to show that this species of squirrel-gopher was very common in many regions of the eastern third of the State about fifteen years ago.